

UNIVERSITY OF PENNSYLVANIA

AN EXPERIMENTAL STUDY OF
VIVIDNESS IN LEARNING
AND RETENTION

WILLIAM LYNFORD VAN BUSKIRK

A THESIS
IN PSYCHOLOGY

PRESENTED TO THE FACULTY OF THE GRADUATE SCHOOL IN
PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY

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INTRODUCTION

The opinion that vividness is a condition favorable to learning enjoys extensive acceptance among psychologists who are concerned with the so-called secondary laws of association. In a critical review of the phenomena of learning, Lashley¹ intimates that intensity and vividness 'apply more widely' than any of the other secondary laws, but he hastens to suggest that this seemingly wide applicability may be due to the fact that "we know so little about them."

In so far as vividness is concerned his point is well taken. The experimental evidence upon which the vividness generalization is based is distinctive in its paucity as well as for its inadequate methodology. All of the few studies are primarily concerned with the relative significance of frequency, recency, primacy, and vividness, and there is little accord as to the importance of the last three. One emerges from a perusal of these works with the conclusion that vividness is a condition favorable to learning of less importance than frequency. A more specific conclusion is impossible.

Moreover, it seems to the writer that the methods used in these investigations were such as to obscure the value of the 'vivid.' In the first place, the material to be learned was exposed only once to a subject. The subject then reproduced by direct recall, prompting, or the treffer method. No one would question the statement that partial learning of this sort does not give a true picture of what occurs in more complete learning. Secondly, methodology is at fault in that there has been no adequate standard for the comparison of the weighted

¹ Lashley, K. S., *Nervous mechanisms in learning. Foundations of experimental psychology*, Clark University Press, Worcester, Mass.; 524-563.

and non-weighted units. The usual procedure is to state the number of times the weighted unit occurred, or to express this in terms of its possible occurrence. Such statements give no reliable clue as to just how much vividness may have affected the occurrence of that unit.

Calkins² realized the need for such a standard and constructed one based upon half of her 1200 series. However, she makes little use of it in the interpretation of her results. If one computes the effect of vividness using her standard, it will be found that its average effectiveness of 48 per cent as reported by her dwindles to 21.7 per cent for series of ten and twelve units. Welch and Burnett³ report the findings of Lamb and Waterman who investigated the relative importance of the four secondary laws. Lamb's standard of comparison consisted of the non-weighted units in the same series. Waterman used the same standard. Recently, Jersild⁴ used a standard of the same sort.

The writer believes that such standards are not sufficiently refined to show just what part vividness may have played in the occurrence of the vivid. Comparing the vivid with the average occurrence of all of the unweighted units in the series, fails to account for the fact that the position of a unit in a series influences its occurrence in immediate reproduction.⁵ Nor will variation of the position of the vivid in the series overcome the difficulty since it seems likely that the vivid itself may facilitate or inhibit the reproduction of the preceding or following unit or both.

Another consideration which has been neglected in the study of vividness is that of its retentive value. All of the investigations mentioned above are concerned only with immediate reproduction.

The present experiment was devised as an attempt to ob-

² Calkins, M. W., Association, *Psychol. Rev.*, 1894, I, 476-483.

³ Welch, G. B. and Burnett, C. T., Is primacy a factor in association formation, *Amer. Jour. Psychol.*, 1924, 35, 396-401.

⁴ Jersild, Arthur, Primacy, recency, frequency, and vividness, *JOURN. EXPER. PSYCHOL.*, 1929, 12, 58-70.

⁵ Robinson, E. S. and Brown, M. A., Effect of serial position upon memorization, *Amer. Jour. Psychol.*, 1926, 37, 538-552. See also, Jenkins, J. G. and Dallenback, K. S., The effect of serial position upon recall, *Amer. Jour. Psychol.*, 1927, 38, 285-291.

tain an objective evaluation of the effect of vividness in learning, and of the persistence of that effect over different intervals of time. It aims to measure this effect in terms of an adequate standard of non-vividness, rather than in terms of the relative significance of primacy, recency, and frequency as compared with vividness.

Such a standard may be constructed by determining the order in which a given subject acquires the units of a series, and from this result selecting a unit as a standard. In a like series, in a position comparable to the position occupied by the "standard" unit in the non-weighted series, is placed a vivid unit. The frequency with which the vivid unit appears in the total trials necessary to learn the series may then be compared with that of the standard unit in the non-weighted series. Such a situation demands the use of nonsense material and necessitates the assumption that the units be of equal associational difficulty. This assumption is probably justified in treating of massed results.

It was decided that the 'standard' position should be that of the unit which occurred with least frequency for any given individual. The choice may be criticised in that there is greater possibility for improvement here than at any other position in the series. However, the choice seems justified in that improvement at this point must overcome the original positional difficulty.

The method has several advantages over the usual procedure. First, by having the subject actually 'learn' the whole series we are able to observe the effect of the 'vivid' throughout the entire process. Secondly the effect of individual variations in positional difficulty is eliminated, since the effect of vividness is calculated for each individual in terms of what, for him, is the most difficult position. Thirdly, the effect that the 'vivid' may exert upon other units of the series does not affect the standard in any way.

The only problem which remains is to satisfy the vivid condition. In this case, the "vivid" is a large red syllable on a green background, as compared with a smaller black syllable on a white ground. Increase in the size of the letters fulfills

the condition of those who would define vividness as the intensity of stimulation. The combination of color and increased size, appearing in an achromatic series, should satisfy those who hold that the "vivid" is the unusual. Again, its color should meet the approval of those who agree with the thought of Calkins⁶ who defined vividness as the 'vague and elusive,' the 'unusual,' or the 'object of instinctive, and therefore of psychologically inexplicable interest.' Finally, it adds something to all of this in that red letters on a green background are far less legible than black letters on a white ground.⁷

CONDITIONS

Subjects.—One hundred and two subjects were used in the experiment. Eighty-five were members of the upper classes in the Wharton School of the University of Pennsylvania; two were students in the School of Education in the same institution; and fifteen were pupils in the high school at Blakely, Pennsylvania.⁸ Of the total, seven were female and ninety-five were male. The university subjects were volunteers; the high school pupils were sent to the E by the teachers in charge of the study hall.

None of the S's knew the object of the experiment. Most of them believed E to be working on an advertising problem.

Except for a few cases in relearning the experiment was performed with one S at a time. A few of the S's forgot the exact time of their appointments, in which case E permitted them to relearn with one other S present.

Apparatus.—The apparatus consisted of a metronome and three series of nine nonsense syllables, each syllable on a cardboard background, six by ten inches, as follows:

Series I: pef, yib, vor, zut, ras, teg, nad, sov, fik.

Series II: tol, hir, gah, pem, dak, fon, tuv, nim, ker.

Series III: series two in red and green.

In series I and II the letters were 120 point, black, gummed Gothic 'caps' on a white ground. Series three differed in that the letters were 144 point red Gothic 'caps' on a green background.

Most of the syllables were selected from those used by Lamb and Waterman.⁹ In placing them in the series the E arranged them so that the same vowel occurred with the same frequency in each series. This was an attempt to carry the equalization of difficulty a step further than that implied in the nature of the nonsense syllable.

⁶ Calkins, M. W., Association, *Psychol. Rev.*, 1896, 3, 32-49.

⁷ Outdoor Advertising—the Modern Marketing Force, Outdoor Advertising Association of America, 1928, 76-78.

⁸ The writer wishes to acknowledge his indebtedness to Mr. H. B. Anthony, Superintendent of Schools, for his coöperation in securing these subjects.

⁹ Lamb, H. W., Primacy, recency, frequency, and vividness. Waterman, M. O. Primacy, recency, frequency, and vividness. Reported by Welch, G. B. and Burnett, C. T., Is primacy a factor in association formation, *Amer. Journ. Psychol.*, 1924, 35, 396-401.

Method.—S and E were seated at opposite ends of a five foot table when the work was done at the university. At the high school S and E sat facing each other at classroom desks placed approximately five feet apart.

In presenting a series E held the cards perpendicular to the surface of the table with his left hand in such a manner that as he pushed one card forward with his right hand, the card behind it was exposed to S. The first syllable in each series was preceded by a blank white card. At E's left a metronome beat 70 times per minute. On every second beat a card was pushed forward.

LEARNING I

Instructions: "I am going to show you a series of nonsense words. Nonsense words are three letter words which have no meaning. There are nine words in the series, one on each of these cards. I shall show them to you one at a time. When you have seen all the words, write as many as you can remember on the paper. When you have written all of the words that you can remember, cover what you have written with the cardboard and I'll show you the words again. Again, you write all of the words that you remember regardless of whether you have written them before or not. Every time write every word that you remember. This will continue until you can write all nine words after a single showing. The object is to learn the series. Do you understand?"

If S asked if the 'words' were to be learned in order, he was told to learn them as he pleased.

Upon completion of instructions Series I was shown repeatedly to S, one syllable at a time. After each showing S wrote as many of the words as he could remember. When S reported that he had nine syllables, E examined them and told S how many were correct. If additional presentations were needed the experiment continued until S wrote all nine syllables correctly.

S's paper was then examined to find the syllable which occurred least frequently in the total number of trials. In the event of a tie, the syllable nearest the center of the series was selected, unless the results indicated a tendency of the S to acquire the syllables successively from one end of the series to the other. In this case the syllable nearest to the end was chosen.

LEARNING II

As soon as this calculation was made, Series II was prepared by placing a vivid syllable from Series III in the same position in Series II that the last learned syllable occupied in Series I.

Instructions: "Here is another series of the same kind. There are nine words in it. Will you learn it as you learned the first?"

When Series II had been learned S was asked to report again at a definite time, either one week or two weeks later. E also requested S not to think of what he had learned.

The subjects were divided into two groups. Group I consisted of 51 S's who reported after an interval of one week. Group II, in which there were 50 S's¹⁰, reported after a two week interval. The selection of these groups was determined solely by the days on which the S's appeared for the original learning. Those who reported on Monday and Tuesday were assigned to the two week group. Those who reported on the remaining days were asked to return one week later.

The same method of relearning was used for both groups. First S reproduced as many syllables as he could by direct recall, after which he relearned each series. In

¹⁰ Fifty-one S's were assigned to this group. One failed to report for relearning.

relearning, a black syllable on a white ground was substituted for the red syllable in Series II.

Instructions: "Take this paper and write as many of the words as you remember regardless of the series in which you learned them. Just write them down as they come to your mind."

When S announced that he couldn't remember any more, Series I was relearned.

Instructions: "Now we'll learn Series I again."

Next, Series II was relearned.

"Now we'll learn Series II again."

RESULTS

The effect of vividness is to be measured in terms of the occurrence of a vivid syllable in one series as compared with the occurrence of a standard syllable in another series. Since, only a few S's learned both series with the same number of presentations for each series, it seemed advisable to present the results as percentages. Accordingly, the percent occurrence for the last learned syllable and for the vivid syllable were computed for each S. These, in turn, were averaged and presented in the tables under the heading 'Average Occurrence.' The percentages represent the number of times the S's reproduced the given syllable in relation to the total possible times they might have reproduced it; *i.e.*, the number of presentations of the series in which the syllable occurred. Thus, for any given S, the occurrence of a syllable was recorded as 20 percent if that syllable occurred twice in learning a series for which he required ten presentations.

The results for learning have been presented in two groups to facilitate the reader in comparing the results of each group in learning with their results in relearning.

TABLE I
LEARNING

Group	Number of Subjects	Standard Average Occurrence (%)	Vivid Average Occurrence (%)
I.....	51	25.53 (11.36)	82.04 (19.53)
II.....	51	27.55 (11.78)	84.70 (20.11)
I and II combined.....	102	26.54	83.37

The Roman numeral under 'Group' indicates whether the S's in the group reported for relearning one or two weeks later. In the column headed 'Number of Subjects' is indicated the

number of subjects comprising the group, which is the basis upon which the averages are computed. Under the column 'Standard' is given the average occurrence of the standard syllable. Under 'Vivid' is shown the average occurrence of the vivid syllable. The figures in parentheses beside each average are the standard deviations of the averages. The bottom row represents the combined learning results for the two groups.

TABLE II
RELEARNING

Group	Number of Subjects	Standard Average Occurrence (%)	Vivid Average Occurrence (%)
I.....	51	64.69 (27.88)	84.45 (23.22)
II.....	50	58.38 (25.69)	75.82 (27.80)

The Roman numeral I indicates that the relearning took place after an interval of one week while II indicates a two week interval. The averages are based upon the number of times the vivid or standard was reproduced in direct recall and relearning in proportion to the number of times it might have occurred. If the syllable occurred in direct recall it was recorded as 100 percent; if not, this was recorded as one presentation in which it might possibly have occurred. The direct recalls are included in the averages.

TABLE III
DIRECT RECALL

Group	Standard		Vivid	
	Number of Subjects	Percent of Group	Number of Subjects	Percent of Group
I.....	15	29.41	33	64.71
II.....	9	18.00	25	50.00

Under "Standard" and "Vivid" are shown the number of S's who recalled the standard and vivid syllables after one and two week intervals before the material was presented for relearning.

1. Under the heading Av. Vivid-Av. Standard are indicated the conditions and groups for which this difference was

TABLE IV
DIFFERENCES

	Obtained Difference	Sigma Difference	Reliability Obt. Diff. Sigma Diff.
1. Av. Vivid-Av. Standard			
A. Learning			
Group I.	56.51	3.18	17.77
Group II.	57.15	3.27	17.48
B. Relearning			
Group I.	19.76	5.08	3.89
Group II.	17.44	5.35	3.26
2. Learn V-Relearn V			
Group II (2 wk.)	8.88	4.85	1.85
3. Relearn St'd-Learn St'd			
Group I.	39.16	4.23	9.26
Group II.	30.83	3.96	7.78

found. The heading indicates that the average occurrence of the standard syllable has been subtracted from the average occurrence of the vivid syllable. Thus, the difference represents the actual effectiveness which may be attributed to vividness. The significance of the difference is indicated in the last column.

2. Under Learn V-Relearn V is indicated the difference between the occurrence of the vivid syllable in learning and its occurrence in relearning after a two week interval.

3. Under Relearn St'd-Learn St'd are shown the increases in relearning of the occurrence of the standard syllable over its occurrence in learning.

DISCUSSION

The results indicate that vividness, as defined in the present investigation, should occupy a firm position as one of the more important of the conditions favoring learning. In Table IV, the difference between the occurrence of the vivid and the standard syllables in learning is high for each group. (Group I, 56.51 percent; group II, 57.15 percent.) These differences reveal that vividness effects a marked economy in learning, and their exceptional statistical significance adds weight to the contention.

It is interesting to compare these figures with those reported in other papers. In this respect the present experiment shows an advantage for the vivid which is far in excess of that shown in previous reports. After subtracting the 26.3

percent occurrence of her standard from Calkins' ¹¹ 48 percent occurrence of the vivid, the present findings exceed hers by 35.12 percent. In a later paper ¹² she reports vividness as 52.2 percent against a normal of 20.8 percent. Lamb ¹³ reports an advantage for the vivid which is only 7 percent in excess of his 36 percent occurrence of all of the unweighted syllables in the series, while Waterman's ¹⁴ report is still lower being only 2 percent higher than the 20 percent occurrence of the unweighted units.

The same disparity persists when the average occurrence of the vivid unit alone is considered. Again one finds that the 83.37 percent (Table I) average occurrence of the vivid syllable in this experiment is larger than that reported in previous papers. Calkins' reports of 48 percent and 52.2 percent are 35.37 percent and 31.17 percent lower than the present results. Lamb's result is 40.37 percent lower and Waterman's, 61.37 percent lower. Jersild's ¹⁵ report is more difficult to compare because his results were treated in a different manner. He reports that the vivid occurred 176 times in a possible 253, or approximately 70 percent of the time according to the manner of treatment in the present paper. This finding is more in accord with that of the present investigation, but was obtained only with what Jersild terms his 'most effective vivid condition'; *i.e.*, 'Now get this.'

When the positional difficulty which vividness had to overcome in the present experiment is considered, the marked economy effected by the vivid condition becomes increasingly significant. It reveals that vividness is of far more importance than has hitherto been shown. The writer believes that the difference between the present results and those reported in previous investigations is due largely to a difference in

¹¹ Calkins, M. W., Association, *Psychol. Rev.*, 1894, 1, 476-483.

¹² Calkins, M. W., Association, *Psychol. Rev.*, 1896, 3, 32-49.

¹³ Lamb, H. W., Primacy, recency, frequency, and vividness. Reported by Welch, G. B. and Burnett, C. T., Is primacy a factor in association formation, *Amer. Journ. Psychol.*, 1924, 35, 396-401.

¹⁴ Waterman, M. O., Primacy, recency, frequency, and vividness. Reported by Welch, G. B. and Burnett, C. T., Is primacy a factor in association formation, *Amer. Journ. Psychol.*, 1924, 35, 396-401.

¹⁵ Jersild, Arthur, Primacy, recency, frequency, and vividness, *JOURN. EXPER. PSYCHOL.*, 1929, 12, 58-70.

method. In former papers the vivid syllable was recorded as effective only if it occurred after the first and only presentation. Consequently, there was less chance for it to be effective than in the present experiment where the material was presented as many times as were necessary for the subjects to attain a given standard of perfection. That the results obtained under the latter conditions are so much higher than those obtained with the former procedure serves to emphasize the point that the present experimental conditions afford a better opportunity for the investigation of the effect of vividness in learning.

As for its retentive value, further inspection of Table IV (Difference) well suffice to show that here, as well as in learning, vividness is a favorable condition. The differences between the occurrence of the standard and vivid syllables both for the one week and for the two week intervals, 19.76 percent and 17.44 percent respectively, lie within the scope of perfect reliability. Table III shows that these differences are considerably larger if limited to direct recall. After an interval of one week 64.71 percent of the subjects recalled the vivid syllable before the series was presented for relearning while only 29.41 percent of them recalled the standard, a difference of 35.3 percent. Likewise, after two weeks 50 percent recalled the vivid as against 18 percent for the standard, a difference of 32 percent.

Comparison of these figures with the differences shown in learning (56.51 percent) seems to indicate that vividness, while clearly effective in retention, is less effective here than in learning. Actually this is not the case. What happens is that the standard shows relative gain. In Table IV, under the heading 'Relearning St'd—Learning St'd,' is found a 39.16 percent gain in the occurrence of the standard after one week and a 30.83 percent gain after a two week interval. The corresponding figures for the vivid syllable may be computed from Tables I and II. We find that after a one week interval the occurrence of the vivid syllable increases by 2.41 percent over its occurrence in learning and that after a two week interval it decreases by 8.88 percent. The differences between the occurrence of the standard in learning and re-

learning for both intervals are much greater than the corresponding differences in the occurrence of the vivid syllable. Thus it appears that that which is difficult to learn (the standard is the last learned syllable in the first series) shows relative gain in retentive value over that which is easily learned (the vivid). This statement receives additional substantiation from the remarks of many subjects upon recalling or seeing the standard syllable in relearning. Often a subject remarked that this was the word which gave him so much trouble in learning.

That vividness is actually as significant in retention as in learning seems to be evident in view of the fact that in relearning after one week it occurred 84.45 percent of the time that it might have occurred. This figure is slightly higher than that for its occurrence in learning. After a two week interval, one finds that its effect decreases by 8.88 percent. The index of reliability (1.85), however, indicates that the decrease is not significant.

Furthermore, it seems unlikely that variations in time alter appreciably the effect of the vivid in relation to the standard since the difference between the occurrence of the vivid and the standard syllables after one week (19.76 percent) is only slightly more than after two weeks (17.44 percent). Inspection of the sigmas of these differences indicates clearly that the difference between them is negligible.

CONCLUSIONS

The results of the present study seem to warrant the following statements:

1. The procedure followed in this experiment is more conducive to the investigation of the effect of vividness in learning than the method used in previous studies.
2. The economy effected by vividness in learning is greater than has heretofore been shown.
3. The effect of vividness in learning tends to persist with the passage of time.
4. That which is difficult to learn shows relative gain over that which is easily learned.

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